~~SECRET~~

This document consists of 57 pages
Copy No. 3 of 4 Series A

MANHATTAN DISTRICT HISTORY

BOOK VIII, LOS ALAMOS PROJECT (Y) - VOLUME 3, AUXILIARY ACTIVITIES

CHAPTER 8, OPERATION CROSSROADS

CLASSIFICATION CANCELLED
CHANGED TO
BY AUTHORITY OF DOE/DPC
JOHN S. HARLOCK
REVIEWED BY
9/14/97
DATE

DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW
1st REVIEW DATE: 9.16.05
AUTHORITY: DC DD
NAME:
2nd REVIEW DATE: 10.3.05
AUTHORITY:
NAME:
DETERMINATION (CIRCLE NUMBER(S))
1. CLASSIFICATION RETAINED
2. CLASSIFICATION CHANGED TO:
3. CONTAINS NO DOE CLASSIFIED INFO
4. COORDINATE WITH:
5. CLASSIFICATION CANCELED
6. CLASSIFIED INFO BRACKETED
7. OTHER (SPECIFY):

RESTRICTED DATA
Atomic Energy Act of 1946
Restricted Data
Clearance Required

~~SECRET~~

FOREWORD

The official reports of Operation Crossroads (See particularly the preface to "Bombs at Bikini", by W.A. Shurcliff, Historian of Joint Task Force One.) emphasize the joint nature of the enterprise, and properly so. The two tests of this operation were carried out at Bikini by the united efforts of the Army, the Navy and the Air Forces, and many of their component parts; Joint Task Force One, the agency which executed the operation, was, as its name clearly shows, a joint agency, created by the Joint Chiefs of Staff and responsible to them only; finally, the official reports of the operation as a whole were joint reports and were submitted directly to the Joint Chiefs of Staff, without prior approval by anyone.

This chapter differs from the official reports of this operation both in its nature and in its intent. The intent of this chapter is to describe, primarily, the part played by the Manhattan District and by its personnel in the conduct of the tests, and in the numerous activities which preceded and accompanied them. For an integral part of the Manhattan District History, such intent is proper and desirable, but the indulgence of the reader is requested if, by emphasizing the Manhattan District, the writers have seemed inadvertently to belittle the part played by any other agency or its personnel.

This chapter supplements the brief information on Operation Crossroads in the supplement to Volume 2 of this book (principally paragraphs 1.38 to 1.49 of that supplement).

September 1948

RESTRICTED DATA
Atomic Energy Act 1946
Specific Restricted Data
Clearance Required

[redacted]

MANHATTAN DISTRICT HISTORY

BOOK VIII, LOS ALAMOS PROJECT (Y)

VOLUME 3, AUXILIARY ACTIVITIES

CHAPTER 8, OPERATION CROSSROADS

TABLE OF CONTENTS

Paragraph Number.	FOREWORD	Page.
1.	General.	8.1
2.	Early Studies and Suggestions.	8.3
	a. At Los Alamos.	8.3
	b. By a Senator.	8.4
	c. By the Armed Services.	8.5
3.	Authorization.	8.7
4.	Designation of Commander of Joint Task Force One.	8.8
5.	Designation of Deputy Task Force Commander for Technical Direction.	8.8
6.	The Tests.	8.10
7.	Official Account, by Joint Task Force One, of Participation by the Manhattan District.	8.12
8.	Los Alamos B-Division.	8.20
	a. Preparations in the United States.	8.20
	b. Technical responsibilities of the Measurement Section.	8.27
	c. Overseas Activities of the Measurement Section.	8.30
9.	Manhattan District Personnel.	8.38

[redacted]

10. Results and Conclusions. 3.45

APPENDIX A - Organization Charts.

APPENDIX B - References.

1. General.

Operation Crossroads was an experimental operation. Its original major purpose was to determine the effects of atomic explosives against naval vessels, in order to appraise the strategic implications of atomic bombs in respect to naval design and tactics. As the operation developed, however, its objectives expanded, and before the tests were carried out the over-all purposes had grown to include the collection of vast amounts of information for future guidance: in all types of defensive military design and military tactics; in the design, manufacture and offensive use of atomic bombs themselves; and in the development of measures for radiological safety, and for the treatment of radiological injury. (App. B1, B2.)

The unique nature of the operation was inherent not only in its huge size--in the huge numbers of the participating personnel, and the huge amounts of test equipment and numbers of instruments involved--it was inherent also in the tremendous glare of publicity to which the tests were exposed, and above all to the extraordinary fact that the weapons whose performance was exposed to this publicity were still classified, secret, weapons, which had never even been seen except by a few men in the inner circles of the Manhattan District and by those who had assisted in the three previous atomic bomb detonations. It has been truly said that the operation was "the most observed, most photographed, most talked-of scientific test ever conducted" (App. B2, p. 15). Paradoxically, it may also be said that it was the most publicly advertised secret test ever conducted.

The main object of submitting the spectacular phases of the operation to the glare of publicity, despite the security risks which this policy involved, was obvious--more obvious at the time, perhaps, than now. It was desirable that the whole world should know and appreciate the devastating power of the atomic bomb, in order that the peoples of the world might properly appraise the importance of organized efforts to prevent atomic bombs from ever being used in warfare again.

Yet public approval of the operation beforehand was by no means unanimous. A Gallup Poll in April 1946 showed 47 percent of the public approved and 35 percent opposed the continuation of the test program at that time, with 18 percent holding no opinion on the subject. (App. B3, 1.17.) Many persons, including some thoughtful technical men and some irresponsible scare-mongers, regarded the tests as undesirable or unnecessary, and a wide variety of objections was raised. (App. B2, pp. 5,6,35.)

The most thought-provoking objection was that of the technical men who maintained that the tests were unnecessary. They claimed that with the data already obtained from the atomic bomb detonations at Alamogordo, and at Hiroshima and Nagasaki, together with some further laboratory tests, the desired results could be predicted from computations by theoretical physicists alone, without any further bomb tests. (App. B2, P. 6.)

Some weight was later added to this objection by proof of the extraordinary accuracy of some of the predictions made by the scientists before the tests. The following is quoted from the

preliminary statement by the Evaluation Board of the Joint Chiefs of Staff, shortly after one of the tests: "To a degree which the Board finds remarkable, the visible phenomena of explosion followed the predictions made by civilian and service phenomenologists attached to Joint Task Force One." (App. B2, p. 196.)

It seems probable, however, that the technical men who raised this objection have already recognized that it is not valid, or that they would quickly do so if permitted to study the vast amount of detailed information which was provided by the tests.

2. Early Studies and Suggestions.

a. At Los Alamos.

As early as 1944, under the blanket of secrecy which at that time completely covered all the activities of the Manhattan District, the scientists at Los Alamos undertook investigations and studies of the effects of bomb bursts at and under the surface of bodies of water. The purpose was to determine the relative effectiveness of such bursts compared with the air bursts toward which the major efforts of the Laboratory continued to be directed. If the water bursts gave promise of being highly effective they could be used to advantage against harbors and ships during the war.

In September 1944, the Ordnance Division of the Los Alamos Laboratory organized Group O-6, "Water Delivery, Exterior Ballistics" under M.M. Shapiro, with the assistance of W.G. Penny and John von Neumann, to carry on such studies, which had been begun previously by E.M. McMillan. Experiments were conducted on a small scale, with high explosives in small quantities. As stated in

[redacted]

Volume 2 of this book, par. 14.23: "From the experimental data it was discovered, contrary to expectation, that a surface explosion produced larger gravity waves than a subsurface explosion of the same size. From a theoretical analysis scaling laws were derived which made it possible to predict with some assurance the effects of the surface or near-surface detonation of atomic bombs."

It is pertinent to note that the thinking of the Manhattan District, until after the cessation of hostilities, was directed toward the production and delivery of bombs which would be capable of greatest damage by blast and fire, with the least possible radiation effects. In this respect the purpose of the early studies at Los Alamos differed from the purpose of the tests at Bikini. The tests of Operation Crossroads were intended to cover all the effects of the atomic bomb--from radiation as well as blast and fire. Even if some nations should continue to look with disfavor on the use of radioactivity as a main weapon, there was of course no assurance that some future belligerent would not have a different view, and the fullest possible knowledge of radiation effects was therefore imperative. It was because of the evidently superior results of air bursts in the realm of blast and fire damage that the Manhattan District did not pursue the studies of water bursts more intensively.

b. By a Senator.

After the bombings at Hiroshima and Nagasaki, on 6 and 9 August 1945, and the public announcements which followed, many naval men and others began to wonder what might be the effect of an atomic bomb if it were used against naval vessels. Senator

[redacted]

Brien McMahon (D. Conn.), who later became chairman of the Senate's Special Committee on Atomic Energy, was the first man in authority to pick up this question and suggest means for its determination. In a speech which he delivered on 25 August 1945, the Senator said: "In order to test the destructive powers of the atomic bomb against naval vessels, I would like to see these Japanese naval ships taken to sea and an atomic bomb dropped on them. The resulting explosion should prove to us just how effective the atomic bomb is when used against the giant naval ships. I can think of no better use for these Jap ships." (App. B2, p. 10.)

c. By the Armed Services.

On 14 September 1945, Lieutenant General B.M. Giles, Commanding General of the U.S.A. Strategic Air Forces, at headquarters in Tokyo, proposed that at least two atomic bombs be tested against the remnants of the Japanese Fleet, and this proposal was immediately transmitted by Major General C.E. LeMay to General H.H. Arnold and Lieutenant General C.A. Spaatz, in Washington. On 18 September General Arnold submitted the proposal to the Joint Chiefs of Staff, of which he was a member. (The other members at that time were General G.C. Marshall, Admiral E.J. King, and Admiral W.D. Leahy.) Admiral King, on 18 October, recommended a further development of the proposal: that the projected tests should be performed under the control of the Joint Chiefs of Staff and that all related parts of the Army and Navy should participate; that one bomb should be detonated in the air and another in the water; that a few modern type vessels of the United States Navy should be included in the

the target array. (App. B2, pp. 10,11; 31, par. 51.)

3. Authorization.

The Joint Staff Planners, a permanent working committee of the Joint Chiefs of Staff, were directed, on 10 November 1945, to prepare a general plan to determine the tests which should be made and the specific groups which should make them. The Joint Staff Planners appointed a subcommittee, commonly called the "LeMay Subcommittee", which was composed (during the major part of their work) of the following officers:

Major General C.E. LeMay

Brigadier General W.A. Borden

Colonel C.H. Bonesteel

Captain G.W. Anderson, Jr. (Navy)

Captain V.L. Pottle (Navy)

Commodore (now Rear Admiral) W.S. Parsons.

Based on the work of this Subcommittee, the Joint Staff Planners submitted a detailed plan to the Joint Chiefs of Staff, who accepted it, with a few minor changes, on 28 December 1945. (App. B2, pp. 11,12.)

This plan, accompanied by a detailed administrative and technical plan of action submitted by Vice Admiral W.H.P. Blandy, received the preliminary approval of the Joint Chiefs of Staff, and then of the Secretaries of War and Navy. It was approved by President Truman on 10 January 1946. (App. B2, p. 13.) Congressional approval of the operation as a whole was later indicated by the passage of H.J. Res 307, on 14 June 1946, authorizing the use of 33 U.S. combat vessels in the target arrays of the tests.

[redacted]

On 11 January 1946, the Joint Chiefs of Staff issued a directive to Admiral Blandy, by which he was designated commander of "a task force under the Joint Chiefs of Staff for the purpose of conducting tests for the determination of the effects of atomic explosives against naval vessels in order to appraise the strategic implications of atomic bombs including the results on naval design and tactics . . ." (App. B2, pp. 14,15.)

The directive stated further: "The general requirements of the test will be to determine the effects of atomic explosives against ships selected to give good representation of construction of modern naval and merchant vessels suitably disposed to give a gradation of damage from maximum to minimum. It is desired to include in the tests both air detonation and underwater detonation if the latter is considered feasible. Tests should be so arranged as to take advantage of opportunities to obtain the effects of atomic explosives against ground and air targets and to acquire scientific data of general value if this is practicable."

And the commander of the task force was "authorized to deal directly with agencies of the War and Navy Department . . . including direct access to the Manhattan District."

Joint Task Force One was thus established on 11 January 1946; its existence was to continue for 9 months and 21 days, until its dissolution on 1 November 1946. On 12 January 1946 its mission was christened by Admiral Blandy "Operation Crossroads". (App. B2, pp. 27, 172.)

[redacted]

4. Designation of Commander of Joint Task Force One.

The LeMay Subcommittee, in its deliberations prior to submission of its detailed plan to the Joint Staff Planners, gave careful and detailed consideration to the question of who should be designated the Task Force Commander. The Army Air Forces members of the Subcommittee wanted Major General L.R. Groves, Commanding General of the Manhattan District, to be designated, but because the majority of the activities involved in the planning and execution of the mission would be principally within the province of the Navy, the Subcommittee decided to recommend a Naval officer. On 15 December 1945, Admiral Parsons proposed that Vice Admiral W.H.P. Blandy be selected, in view of his experience as commander of various destroyer groups, cruiser groups and amphibious groups, and in view of his position since November 1945 as Deputy Chief of Naval Operations, Special Weapons. As previously stated, the designation was made official by the Joint Chiefs of Staff on 11 January 1946. (App. B3, 1.5.)

Admiral Blandy delegated the discharge of the majority of his responsibilities to his principal assistants, especially the Deputy Task Force Commander for Technical Direction, the Deputy Task Force Commander for Aviation, the Ground Forces Adviser, and the Chief of Staff. (App. B3, 3.23.)

5. Designation of Deputy Task Force Commander for Technical Direction.

Admiral Blandy formally designated Rear Admiral W.S. Parsons as Deputy Task Force Commander for Technical Direction on 26 February 1946. Admiral Parsons had been officially connected with the

operation from its inception, not only by virtue of his service as a member of the LeMay Subcommittee, and as a member of the Military Advisory Board to the Officer-in-Charge of the Atomic Bomb Project (as alternate for Admiral Purnell), but also because of the significant part he had played during previous years as a key official of the Manhattan District. He had headed the important Ordnance Division at Los Alamos; he had supervised the combat delivery of the Hiroshima bomb, after having personally completed the final assembly of that bomb during flight. At the inception of Operation Crossroads he served as Assistant Chief of Naval Operations, Special Weapons. (App. B3, 3.24; B2, pp. 28, 46.)

Admiral Parsons' responsibilities included planning, organizing, and (through the Chief of Staff, the Technical Director, and the Director of Ship Material) directing all technical activities of the Operation. He also served as liaison officer between Joint Task Force One, as a whole, and the Manhattan District, as a whole.

His technical staff included the following (of whom several were, or had been, members of the Manhattan District forces):

Assistants

Dr. John von Neumann, Scientific Adviser

Capt. F.L. Ashworth (Navy), Assistant for Aviation

Capt. Horacio Rivero (Navy), Assistant for Special Projects

Dr. W.A. Shurcliff, Technical Historian

Technical Administrators

Dr. R.A. Sawyer, Technical Director

Rear Admiral T.A. Solberg, Director of Ship Material

[redacted]

Technical Advisers

Capt. G.M. Lyon (Navy), Safety Adviser

Col. S.L. Warren, Radiological Safety Adviser

(App. B3, 3.24.)

8. The Tests. (App. B1, par. 89-91; B2, pp. 2, 114, 164, 206.)

The magnitude of the operation and the preparations it required may be visualized from some of the statistics. It required the procurement, preparation, assignment, and maintenance of about 42,000 personnel; 242 ships; 156 airplanes; 4 television transmitters; 250 cameras; 5,000 pressure gauges; 25,000 radiation recorders; and approximately the following test animals: 5,000 rats, 200 pigs, 204 goats.

The site selected for the tests by Joint Task Force One, Bikini Atoll, in the Marshall Islands, required the evacuation of only 162 inhabitants, but much had to be done, in preparation of the harbor by removal of underwater obstructions; in studying the water currents and assembling other control data; in construction of shore facilities in preparation for the tests; and in setting up and testing the instruments and arranging the materials and animals, exposed during the tests.

A full dress rehearsal for the first test was held on "Queen Day", 24 June 1946, and Test Able was carried out on 1 July 1946; the first bomb was dropped from a B-29 and detonated at a height of several hundred feet over a target array of 69 ships. The bomb detonated at approximately the planned altitude, but its position horizontally was about 2,000 feet west of the intended bull's eye

[redacted]

ship Nevada (for reasons unknown). Five ships were sunk, including one cruiser, two destroyers and two transports. Many others were damaged. (As the target array was disposed so as to give a gradation of damage from maximum to minimum in accordance with the authorized plan, enumeration of the vessels sunk alone does not provide an informative guide to the destructive power of the bomb; and, especially because of the unexpected failure of the first bomb to hit the bull's eye more accurately, the relative power shown by the air burst of Test Able and the underwater burst of Test Baker cannot be evaluated by mere recital of the number of vessels sunk by each. Nevertheless, the number of vessels sunk is here recorded, because it is the simplest and readiest measure of the effects, and because this measure influenced the popular conception of the results of the tests more than any other).

A rehearsal for the second test was held on "William Day", 19 July 1946, and Test Baker was carried out on 25 July 1946; the second bomb was detonated underwater at a depth of the order of 100 feet, suspended under the LSM 60 (the lagoon was about 180 feet deep), in a target array of 65 ships. Nine ships were sunk, including two battleships, a heavy aircraft carrier, three submarines, a concrete oil barge, a 120-ft. landing craft, and the LSM 60. Other ships were heavily damaged.

It was originally planned to hold a third test, Test C, or Test Charlie, and a considerable amount of work was done in preparation for it. This test was to be a deep (1,000 to 2,000

[redacted]

feet) underwater test. After the successful completion of the first two tests, however, this phase of the Operation was reconsidered and the conclusion was reached that the effort and expense which it would entail, complicated by the increasing shortage of military personnel and available civilian scientists, would not be justified in view of the small amount of additional information which would be obtained. On 7 September 1946, the President, acting on the advice of the Joint Chiefs of Staff, postponed the third test indefinitely.

7. Official Account, by Joint Task Force One, of Participation of the Manhattan District. (App. B3, 3.9 ff.)

The participation of the Manhattan District in Operation Crossroads is described in general terms in the "Technical Report of Operation Crossroads", prepared by Dr. W.A. Shurcliff, Historian, submitted to the Joint Chiefs of Staff by Admiral Blandy on 18 November 1946. Because this was an official report of Operation Crossroads, it is the most authoritative account heretofore available and the sections on the Manhattan District are therefore quoted almost in their entirety, as follows (App. B3, 3.9, 3.10.):

"The Manhattan Engineer District, the group which has made all the atomic bombs produced to date, operated throughout the Operation with relative independence . . .

"A. Pre-JTF-1 Activities. The Manhattan Engineer District assisted the early planning of the Operation as follows:

"1. It made available to the Deputy Task Force Commander for Technical Direction the results of studies it had made on

[redacted]

underwater explosions . . .

Some of the studies--those made in 1944--had been directed towards planning an atomic bomb attack on Japanese Fleet units at Truk Island . . .

Results of all these studies were of especially great assistance in planning Test B, the underwater explosion.

"2. It presented the first detailed technical plan as to how the bombs might best be delivered, detonated, and appraised. This plan, known as the 'Williams Plan', played a central part in many of the earlier discussions, including important discussions held on 19, 20 and 21 Dec 45.

"3. Through Major General L.R. Groves, Commanding General of the Manhattan Engineer Project, Dr. N.E. Bradbury, Director of the Los Alamos Laboratory, and other representatives, it contributed valuable advice in the principal conferences, including conferences attended by the Military Advisory Board to the Officer-in-Charge of the Atomic Bomb Project.*"

(The footnote reads as follows: "*The Military Advisory Board to the Officer-in-Charge of the Atomic Bomb Project was created on 28 Oct 45 to help coordinate and integrate the activities of the War and Navy Departments with the activities of the Manhattan Engineer District. Its membership comprised: Maj. Gen. (now Gen.) C.E. LeMay; Brig. Gen. (now ret. Col.) W.A. Borden; Brig. Gen. G.A. Lincoln; Brig. Gen. Hobart Hewett; Col. H.W. Mansfield; R. Adm. (now Vice Adm.) W.H.P. Blandy; R. Adm. W.R. Purnell; R. Adm. (now Vice Adm.) G.F. Hussey, Jr.; R. Adm. H.G. Bowen; also Maj. Gen. L.R. Groves,

[redacted]

Officer-in-Charge of the Atomic Bomb Project. Lt. Col. J.A. Derry was Acting Secretary. On 20 Nov 45 Commo. (now R. Adm.) W.S. Parsons was designated alternate for R. Adm. W.R. Purnell. It held important meetings on 29 Jan 46 and 19 Feb 46.")

"S. Activities After Creation of JTF-1. After the formal creation of JTF-1, the Manhattan Engineer District assisted JTF-1 principally through the 013 Los Alamos Group and the 013 Radioactivity Group. Also it supplied various key personnel, including Dr. R.A. Sawyer (013), Technical Director.

"The Manhattan Engineer District selected 27 observers for Test A and 20 for Test B."

The Technical Report gives the following information about the "013 Los Alamos Group" (called also the "013H Group) described above as one of the two agencies through which principally the Manhattan District assisted Joint Task Force One (App. B3, 3.43-3.45):

"(a) Function. This Group was responsible for preparing the 'black-box' instrument-starting devices, sending the principal timing signals, assembling the bombs, delivering Bomb B, detonating Bomb B, measuring certain phenomena accompanying the detonations proper, and determining the energy release . . .

"This Group was responsible in varying degrees to three different individuals or groups. In maintaining security as to the bomb itself, it was responsible to Dr. N.E. Bradbury, Director of the Los Alamos Laboratory; and, through Dr. Bradbury, to the Commanding General of the Manhattan Engineer District. In matters

[redacted]

of general policy and particularly in regard to the actual detonating of the bombs, its line of responsibility extended directly to the Deputy Task Force Commander for Technical Direction. In matters requiring coordination with other technical groups it was responsible to the Technical Director.

"(b) Organization. Dr. M.G. Holloway was in charge of this Group. Mr. R.S. Warner, Jr. was his principal assistant. Dr. M.E. Bradbury was present in an advisory capacity, although not formally a participant in the Operation." (Note: It seems quite evident that the writer of the Technical Report restricted his use of the term "participant" to those only who took an active part in the operation overseas; Dr. Bradbury took a leading and significant part throughout the planning stages of the project, as will be shown in a later section of this chapter.)

"The 013H Group included the following subgroups:

Subgroup	Person in Charge
Bomb Operation	Mr. R.S. Warner, Jr.
Bomb Instruments	Dr. M.G. Holloway
Measurements of Instantaneously Produced Gamma Rays	Dr. M.N. Nereson
Measurements of Fast Neutrons	Dr. G.A. Linenberger
Radiochemistry of Bomb Products	Dr. William Rubinson
Measurements of Delayed Gamma Rays, etc.	Dr. J.L. Tuck

[redacted]

Subgroup	Person in Charge
Photography of the Detonation	Dr. B. Brixner
Condenser Gage Measurements	Dr. J. Wieboldt
Time Signals	Dr. J. Wiesner and Dr. H. Weiss
Detonation Phenomena in General	Dr. J. Hirshfelder

"(c) Activities. The Group was berthed on ALBEMARLE and CUMBERLAND SOUND. For Test A, ALBEMARLE was at Kwajalein.

"Bomb A was handed over by the 013H Group to Task Group 1.5 at the special bomb pit on Kwajalein shortly before the dawn take-off of the B-29 'Dave's Dream'. The Group had no responsibility for the aiming and releasing of the bomb, but it did provide two specialists, Ens. D.L. Anderson and Mr. L.D. Smith, to accompany the bomb on the trip to Bikini, and, before the final run, to assist in assembly and tests.

"Whereas the task of preparing and delivering the bomb for Test A presented no new difficulties, preparing and delivering the bomb for Test B presented a number of new and major difficulties. Principal tasks were: rapidly designing, constructing, shipping, and testing the bomb container; arranging for the lowering of the bomb and its container to the proper depth and keeping it there under good mechanical control; developing a method of obtaining from the bomb, in the instant prior to the bursting of its case, the data needed in the gamma-ray-timing method of evaluating the efficiency of the detonation; providing a foolproof system for remotely detonating the bomb at the desired instant and with no

[redacted]

[redacted]

danger of premature detonation."

The "O13 Radioactivity Group" (or"O13R Group") was the second principal agency through which the Manhattan District assisted Joint Task Force One. Its function, organization and activities are described in the Technical Report of 18 November 1946 as follows: (App. B3, 3.42, 3.43):

"(a) Function. This Group was responsible for the protection of personnel of the Task Force from the hazards peculiar to the atomic bomb and to help enable personnel to return safely to the target area at the earliest possible moment. In addition the Group was responsible for making all measurements of radioactivity required in order to estimate the effectiveness of the explosion in producing casualties to target vessel crews. The work involved the prediction of all nuclear radiation intensities (including alpha, beta, and gamma activities and neutron flux; the measurement of the radioactivity in the air, water, and material, on target and operational vessels, and near experimental animals and instruments; the measurement of the exposure of all personnel; and the measurement of gamma and neutron doses on the target ships). . .

"(b) Organization. The Group was headed by Col. S.L. Warren, who had served as Chief of the Manhattan Engineer District Medical Section and who was on leave of absence from the University of Rochester.

"Colonel Warren was assisted by Col. A.A. de Lorimier, Capt. R.J. Buettner, Comdr. D.L. Kauffman, Dr. Herbert Scoville, Jr., Dr. Joseph Hamilton, Dr. Kenneth Scott, Dr. Gerhard Dessauer, Dr. Lauren Donaldson, and Mr. Donald Collins.

[redacted]

"(c) Activities. This Group, berthed principally on the HAVEN, analyzed thousands of radiation-recording devices which had been placed on all target vessels and distributed to personnel of the Task Force. For days and in some cases months after the tests, monitors with radiation-detecting instruments carried out extensive patrols of the lagoon, target ships, islands, the air, and the ocean outside the lagoon until no danger from radioactivity remained. Samples of marine life, water, sand, and ship materials were collected and their radioactivity measured.

"Perhaps the Group's greatest difficulty was in securing and training enough radioactivity monitors. The peak strength of the group was approximately 350, but of this group only 150 were available on any one day for monitoring duty in clearing target vessels, instruments and installations, for example, on the seventh day after B-Day when the demands were at a peak. The remaining personnel were required for administration, maintenance of the instruments used by the monitors, analyses of the samples of water, measurement of the film badges, and the other numerous technical activities in which the Group was engaged."

This general outline, given by excerpts from the Technical Report of Joint Task Force One, brief though it is, indicates that the part played by the Manhattan District in Operation Crossroads was critical and important. Insofar as it goes, this account agrees generally and essentially with the reports written by personnel of the Manhattan District. Such differences or discrepancies as appear are for the most part minor and are due usally to differences of

[redacted]

emphasis. There is one point of seeming importance, however, which merits clarification: the status of Dr. R.A. Sawyer, Technical Director of Joint Task Force One.

In one of the excerpts from the Technical Report quoted above it is stated (App. B3, 3.10) that the Manhattan District "supplied various key personnel, including Dr. R.A. Sawyer (013), Technical Director", and another section of the same report states (App. B3, 3.34): "Dr. R.A. Sawyer became Technical Director (013) of JTF-1 on 11 Jan 46. (For payroll purposes, Dr. Bradbury, acting with the approval of Maj. Gen. L.R. Groves, asked Dr. Sawyer on 9 Jan 46 to accept a nominal post as Associate Director of the Los Alamos Laboratory. Dr. Sawyer accepted and the appointment became effective on 11 Jan 46.)"

The situation with respect to the appointment of Dr. Sawyer is described in some detail in the history of "Los Alamos B Division" (written from reports prepared by or for Dr. Herbert M. Lehr and Dr. M.G. Holloway), which follows, in Paragraph 8 herein. The facts seem to be: that Dr. Sawyer had not been directly connected with the Manhattan District before the preparations for Operation Crossroads began; that Dr. John Williams pointed out, at conferences early in January 1946, the urgent need for the appointment of a Test Director; that Dr. Bradbury recognized that the technical part of the operation should in large measure be controlled by the Los Alamos Laboratory, and, with the approval of General Groves and Admiral Parsons, asked Dr. Sawyer on 9 January 1946 to accept the position of Associate Director of that Laboratory, for the purpose of serving also as Test

[redacted]

Director of Operation Crossroads; and that on 11 January 1946, Dr. Sawyer became Technical Director of the Operation, reporting to the Deputy Task Force Commander for Technical Direction, Admiral Parsons.

As the Technical Report states (App. B3, 3.34), "Dr. Sawyer was a logical choice for this position in view of his previous extensive experience in civilian and military research in applied physics; for example, he had been Director of the Armor and Projectile Laboratory at the U.S. Naval Proving Ground at Dahlgren, Va. During the Operation he was on leave of absence from the University of Michigan, which, during the summer of 1946, made him Dean of the Graduate School."

As the records show (see paragraph 9 hereinafter), numbers of personnel took part in Operation Crossroads while serving in dual capacities, as members of the Los Alamos Laboratory of the Manhattan District and at the same time as members of Joint Task Force One. The cooperative spirit of all concerned in carrying out the operation made this an advantage and not a handicap.

8. Los Alamos B-Division. (From Reports written by Los Alamos personnel.)

a. Preparations in the United States.

A new division at the Los Alamos Laboratory of the Manhattan District, known as the B-Division, was formally organized on 1 February 1946, under Dr. Marshall Holloway, with Mr. Roger S. Warner, Jr., as alternate. Cooperation with, and participation in, Operation Crossroads were concentrated in this Division.

[redacted]

For several months before the organization of B-Division, however, the Los Alamos Laboratory and some of its personnel had been taking an active part in the preparations for the operation.

In the latter part of 1945, in anticipation of Manhattan District participation in the proposed tests, the Director of the Laboratory, Dr. N.E. Bradbury, asked Dr. John Williams to prepare a tentative plan for the tests, based on his considerable experience as principal technical assistant in organizing and conducting the first test of the atomic bomb at Alamogordo, New Mexico. The plan prepared by Dr. Williams was taken to Washington by Dr. Bradbury, Dr. Williams and Mr. Warner, and, after approval in principle by Major General L.R. Groves, it was presented to Vice Admiral Blandy and Rear Admiral Parsons as a basis for planning. The proposal was thoroughly discussed in a series of conferences in Washington between 19 December and 21 December 1945. During these discussions representatives of many military organizations were brought into the planning sessions, as the scope and magnitude of the undertaking developed.

The Williams Plan proposed that the Los Alamos Laboratory and the Manhattan District assume responsibility for:

(1) Coordinating all instrumentation;

(2) Assembling and delivering the atomic bombs, to the aircraft bomb loading pit in the case of the air drop (Test Able), and to the firing point in the case of the underwater burst (Test Baker);

(3) Providing all necessary fusing and firing equipment;

(4) Providing remote control radio timing and firing signals,

[redacted]

including radio transmitters and special receivers constructed to operate a solenoid control on receipt of a selected time signal;

(5) Measuring the efficiency of nuclear reaction by:

(a) Fastax photography of ball of fire;

(b) Radio chemistry;

(c) Gamma timing;

(d) Air blast condenser gauges;

(6) Measuring total radiation;

(7) Preparing a radiological safety plan;

(8) Furnishing available and necessary technical data to other participating activities.

Los Alamos was invited to send representatives to Washington between 8 and 10 January 1946 for a series of organizing and instrumentation conferences, and Dr. Bradbury, Dr. Williams, and Mr. Warner attended these conferences. The organization of the proposed Joint Task Force was discussed with Admiral Blandy and Admiral Parsons. The urgent need for the appointment of a Test Director to assume full responsibility for coordinating the instrumentation plan and the equally important need for a staff to work out and coordinate details with participating activities were pointed out by Dr. Williams. As it was apparent that the Los Alamos Laboratory should have control of the instrumentation plan, on 9 January 1946 Dr. Ralph Sawyer was asked by Dr. Bradbury, with the concurrence of General Groves and Admiral Parsons, to accept the position of Test Director (cf. discussion in paragraph 7 above).

During these conferences the necessity for adequate and immediate

[redacted]

air transportation for Los Alamos personnel within the continental limits of the United States, and later to the target area, which had been requested previously, was again emphasized by Mr. Warner. These requests resulted in the establishment of the "Crossroads Airline" operated by the 58th Wing, based at Roswell, New Mexico. The first scheduled flight was made on 15 January 1946 between Santa Fe, N.M., and Washington, D.C. Other flights were inaugurated later between Santa Fe and Hamilton Field, California, via Long Beach, and overseas to Kwajalein. Special flights were made as the need became apparent.

The remaining weeks of January were devoted to organizing the Los Alamos overseas party. Because of the firm intention of many of the scientists at Los Alamos to terminate relations with Project Y during the spring and summer, some to meet previous commitments and others to have a vacation before returning to their universities, great difficulty was experienced in recruiting an overseas group capable of discharging Los Alamos responsibilities. Eventually, it became necessary to offer inducement and hazard pay, and the organization of the separate B-Division was the inevitable result.

The attached organization charts show the constitution of each Los Alamos group and the general nature of its responsibilities--of the Assembly Section as of 8 March 1946 and of the Measurement Section as of 25 March 1946. The specific responsibilities of the B-Division included items (1) through (5) in the list enumerated above; items (6) and (7) were the responsibility of the Radioactivity Group of the Manhattan District, under Colonel Stafford L. Warren (see paragraph 7 above); and item (8) was, in part, the responsibility

[redacted]

[redacted]

of many parts of the Manhattan District.

Meanwhile, the laboratory ships requested by Los Alamos became available at Naval Ship Yard, Terminal Island, California, for inspection and conversion. During the period 15 to 19 January, an inspection party, headed by Mr. Roger Warner and Mr. Robert Henderson and composed of representatives of the tentative B-Division Groups, inspected these ships and wrote specifications for necessary alterations to adapt USS Albemarle for bomb assembly purposes, USS Cumberland Sound for laboratory and measurement functions, and LCT 1369 for bomb firing purposes. The able cooperation of the Planning, Design and Production personnel at the Navy Ship Yard, Terminal Island, California, made possible the completion of planning and necessary alterations within a deadline date which at first seemed impossible to meet.

To discuss the status of the preparations for Operation Crossroads and possible modifications of the proposed tests, conferences were held in Washington between 13 and 15 February 1946. Project Y was represented by Dr. Bradbury, Dr. Sawyer and Mr. Warner. The possible substitution of a new test, later termed "Detector", for Test Baker as then proposed, was discussed. At this time Test Baker was to be a surface burst and Test Detector was to be an underwater burst. Although there was no agreement among the theorists as to whether Test Baker or Test Detector should be conducted, it was concluded that the Los Alamos B-Division, in conjunction with NSY Terminal Island, should undertake the necessary preliminary engineering planning to discover whether or not Test Detector was feasible.

[redacted]

[redacted]

As a subsequent development, the Deputy Task Force Commander for Technical Direction, Admiral Parsons, decided to carry on preparations for Test Detector concurrently with preparations for Test Baker, the final decision as to which test would be conducted to be made at a later date after further theoretical studies. LSM 60 was accordingly made available at NSY Terminal Island, and Captain A.M. Morgan, USN, of the Navy Yard, Portsmouth, N.H., was appointed by the Technical Director to direct the preparations. Mr. Robert W. Henderson was given responsibility for representing Project Y and the E-Division in the preparations for Test Detector.

To learn at first hand the conditions under which the Crossroads personnel would work and to verify the adequacy of planned facilities so far as the state of construction permitted, an advance inspection party was organized and sent on 17 March 1946 by air to inspect the Bikini-Kwajalein area. This party consisted of Dr. E.B. Doll, leader, Dr. John Williams, consultant, and Messrs. R.A. Bice, H.M. Lehr, and H.W. Russ. Dr. Doll and Dr. Williams returned after a brief visit, and their reports were most useful in continuing the preparations.

On 22 March 1946, three days before the scheduled sailing of USS Albemarle with the Los Alamos Bomb Preparation Group, an inspection of the laboratory ships at Terminal Island Ship Yard was made. General Groves, Dr. Richard Tolman, Colonel H.C. Gee, Admiral Parsons, Dr. Sawyer, Dr. Bradbury, Mr. Warner and Mr. Henderson were among those present.

During the course of this inspection, it was learned from Admiral Blandy that the tests of Operation Crossroads had been delayed approximately six weeks. Advantage was taken of this delay to postpone

[redacted]

[redacted]

the sailing date proposed for LSM 30 on Test Detector from 1 May to 15 May, and this unquestionably influenced the final decision as to whether the second test of the operation was to be Test Detector or the original Test Baker (surface detonation). On 4 May 1946, after successful submergence tests had been completed, decision was made in favor of Test Detector, which was accordingly substituted for the original Test Baker; thereafter, Test Baker was recognized as an underwater test, and the term "Detector" was no longer applied to it.

With additional time available after the official delay of the test, the problem of collecting water samples for chemical analysis to determine the efficiency of the bomb was again examined. The radio chemistry group (B-14) under Dr. William Rubinson reaffirmed their earlier requests for water sample collection as soon as practicable after each shot.

Various schemes to avoid complications incident to the use of remote controlled boats for the collection of the desired water samples were considered and discarded. Eventually it was concluded that radio controlled "drone" boats should be used for the collection of samples. Two parallel programs were undertaken to procure remote control boats. The Manhattan District obtained the release of two JR type Army drone boats in time to load on board USS Cumberland Sound before sailing. The Navy Bureau of Ships released eight LCVP's for conversion and assignment to Task Group 1.1.3 of Joint Task Force One for the primary purpose of collecting water samples and for later use in radiological survey of Bikini Lagoon.

[redacted]

[redacted]

On 17 April 1946 the majority of the Los Alamos personnel for Operation Crossroads sailed in USS Albemarle and USS Cumberland Sound.

b. Technical Responsibilities of the Measurement Section. (App. B4)

The Measurement Section of the Los Alamos B-Division was under the direct supervision of Dr. W.G. Holloway, who, in addition to being leader of this section, was the over-all director of B-Division. In general, the main functions of the groups in this section were the measurements of the efficiencies of the tests, or acting as service groups to those actually performing the measurements. This does not mean that no efforts were made to obtain other information, but determination of efficiencies was given the highest priority. Restrictions on other important physical observations were made necessary by limitations in time and personnel.

As of 30 April 1946, the various groups of the section, and their responsibilities, were as follows:

(1) Group B-9. The Photographic Group, under Berlyn Brixner, had the primary responsibility of photographing with Fastax cameras the expansion of the shock front.

(2) Group B-10. The Fast Neutron Group, under G.A. Linenberger, was to measure the total fast neutron flux, using sulfur detectors mounted on the decks of a dozen vessels within 1200 yards of the aiming point.

(3) Group B-11. The Gamma Timing Group, under Morris Jeveson, was to measure certain times on Test Baker (whether it was carried out at the surface or underwater), by measuring the interval between

[redacted]

[redacted]

a pulse actuated by the signal firing the weapon and a pulse formed in an ionization chamber by the prompt gamma rays upon detonation.

(4) Group B-12. The Electronics Group, under Jerome Wiesner and Herbert Weiss, was divided into three main sections--Timing, Firing, and Gamma Timing--whose functions were interdependent but non-overlapping.

(a) The Timing Section, under Eric Durand, had for its main objectives the turning on of various electrical apparatus by means of radio links, and the precision timing of these operations to time zero of Test Baker. The receivers, filters (band-pass audio filters), and relays of these radio links were constructed as self-contained units complete with antenna, and these units were commonly referred to as "Black Boxes"; hence this section was often called the "Black Box" section of B-12.

(b) The Firing Section, under Herbert Hall, had as its responsibility the arming and firing of the bomb in Test Baker, and the initiation of repeat-back signals that indicated whether the circuits had operated correctly (the "Black Boxes" were not used in the signals of this application because of the greater complication and precision necessary, although the basic circuits were similar). Provisions were made throughout for multiple-channel operation, to avoid failure of the system in the event of failure of some of the component parts.

(c) The Gamma Timing Section, under A.S. Jerrems, had the duty of supplying Group B-11 with the signals that that group

[redacted]

would use. The basic system consisted of the transmission by radio of two short pulses: one, the pulse essentially from the firing signal, and the other, the pulse obtained from a special ionization chamber designed by Group B-11.

(5) Group B-13. The Airborne Blast Gauge Group, under James Wieboldt, was to measure the blast in air at high altitudes, with a view to determining the energy in air blast.

(6) Group B-14. The Radiochemical Group, under William Rubinson, was to determine the efficiency of the explosions by comparing, in samples of air and water near the test sites, the amounts of fission products to the amount of active material left. Since a half-dozen separate analyses had to be made on each of dozens of samples, and all work checked, the total number of analyses came to close to a thousand. This large amount of work was done by chemists working at Kwajalein on the short lived isotopes and at Los Alamos on the longer lived isotopes.

(7) Group B-15. The Phenomenological Group, under J.O. Hirschfelder and J. Magee, compiled (in "Crossroads Handbook", LA550) detailed, predicted descriptions of many aspects of the nuclear explosions. They were the theoretical physics consultants for B-Division and, in addition to guiding the design and preparation work of the measurements groups by their forecasts, they aided in the evaluation and the interpretation of the data taken by these groups. The remarkable accuracy of some of the predictions of this group has already been mentioned.

(8) Group B-16. The Total Radiation Group, under James L. Tuck,

was functionally a part of Colonel Warren's Radiological Group. It was to measure the total radiation received aboard several of the closer target ships, in recording ionisation chamber units.

(Note: the work of the various groups and sections is described in greater detail in Appendix B4.)

e. Overseas Activities of the Measurement Section. (App. B5)

(1) Advance Party. The advance party of B-Division has already been mentioned (in paragraph 8a above). Dr. Bell, Mr. Bice and Mr. Russ were representatives of the Bomb Assembly Group; Mr. Lehr represented the Measurement Section and Dr. John Williams served as consultant. This party arrived at Kwajalein Island, Marshal Islands, on 19 March 1946. Its members were quartered with the 607 CBMU on Kwajalein and maintained headquarters there until the main party arrived. The party's function was to act as advisers for necessary construction on Kwajalein and Bikini and to lay the groundwork for Los Alamos participation in Operation Crossroads.

Although most of the work of the advance party was concerned with construction at Kwajalein and Bikini, it also established liaison with Roi-Namur and Eniwetok. The construction on Kwajalein was done by the 607 CBMU (Construction Battalion Mobile Unit) and consisted of setting up laboratories and pit handling areas. At Bikini construction was done by the 53 NCB (Naval Construction Battalion) and consisted of Fastax tower construction on Bikini and Enyu, and setting up a radio station on Bikini Island.

(2) Continued Preparations. With the arrival of the

Albemarle (AV-5) at Kwajalein on 4 May and the Cumberland Sound (AV-17) at Bikini on 5 May, the advance party was absorbed into the main Los Alamos party.

Within a week after the arrival of the Cumberland Sound, the Fastax Group was moved from the ship to their installations on Bikini and Enyu. These stations were fully occupied and were being made operational for the tests.

At Kwajalein, the Radio Chemists and the Airborne Blast Gauge Group moved into their laboratories from the Albemarle. Although the laboratories were finished structurally, these groups were unable to make full use of their installations until the first two weeks in June, because of inadequate power sources and air conditioning. Nevertheless, these groups met their deadline schedules for readiness for Test Able.

Back at Bikini, the Timing (or Black Box) Section of S-12 started their work of installing the radio links on the target ships, while other members of the group were setting the Timing Control Laboratory aboard the Cumberland Sound in order. Practice in transmitting timing signals was obtained by joining in with the Army Air Group (Task Group 1.5) during their practice drops on Erik Island. In order to test coordination between the "zero" tone from the Cumberland Sound and the actual burst, Lieutenant Commander S. Burrige and Dr. L.B. Thompson set up Black Box operated cameras on the towers of Erik Island to take pictures of the burst. It was found that the tone and the burst occurred within a few tenths of a second and it was decided that both occurrences were in

agreement.

Commander Burriss and Dr. Thompson also carried through successfully the preliminaries for obtaining samples of water in the lagoon, as soon as possible after the shot, by means of the two JR drone boats which had been placed aboard the Cumberland Sound at Terminal Island (see paragraph 8a). The Navy drone boat program (of Task Group 1.1.3) was proven successful, however, and it was decided to drop the JR drone boat program.

During the interval between the ship's arrival and Queen Day, the Cumberland Sound went to its station, 17 nautical miles from Zero point, in order to allow calibration of radio link receivers on board the target ships and on the islands. The first test was on 11 June.

As the measurement section was responsible for installation, testing and maintenance of radiation monitors on the B-17 drone planes, it was necessary for Dr. V.A. Nedzel to make a few trips to Eniwetok to accomplish this. These B-17's were to fill bags with radio-active particles from the cloud resulting from the bomb.

On 2 June, the LSM-60 arrived at Bikini aboard the LSD-4, and immediately the Firing Section and the Gamma Timing Section (of Group B-12) moved aboard to install their equipment for Test Baker. The installations were finished by 11 June. Tests made while the Cumberland Sound was at sea on that date proved unsatisfactory, showing trouble with the repeat-back circuit. Another test at sea on 20 June proved satisfactory in all respects.

The measurement groups on Kwajalein consisted of the Radiochemical

Group, B-14, and the Airborne Blast Gauge Group, B-13. They were located in Quonset huts on the southwestern part of the island. Both groups participated in Tests Able and Baker and made measurements of both shots. The Radio Chemists, after obtaining and analysing samples of the lagoon water by drone boat and samples of the cloud from drone planes, determined efficiencies. The Blast Gauge Group dropped condenser blast gauges immediately before each shot and received records of the air blast, at 7 miles slant range. This group also obtained practice by participating in practice drops on Erik Island. In the first test, the air blast measurement permitted the bomb efficiency to be calculated, but in the second test, the measurement of the air blast furnished no complete estimate of the efficiency.

(5) Queen Day. By Queen Day minus one, all installations were complete on ships and islands, and only adjustments that would have to wait until nearly the last minute remained. Queen minus one was announced at 0900 L ("L" signifies Bikini local time), 22 June; immediately thereafter the field parties left the Cumberland Sound to perform their final functions. Radio contact was maintained between the ship and all field parties in case emergencies should arise. At noon of the same day, as the support ships started to leave the lagoon, and target vessel crews were evacuated, the need for radio contact became more evident. No incidents occurred. All parties returned to the ship by 1800 L, after having accomplished their missions. That night at 2230 L, Queen Day was cancelled because of weather, and

the next day became Queen minus one. The majority of the field parties went out again on that day and returned by dark.

On the morning of Queen Day, 24 June 1946, the Cumberland Sound moved out of the lagoon and headed for her station, 17 nautical miles from Zero. Coordination between the ship and the bomb-carrying aircraft was perfect, and all timing signals went out properly. After the rehearsal shot and before re-entry, the drone boats were used and picked up simulated radioactive samples. The samples were transferred to a destroyer and rushed to Kwajalein. Also, simulated drone plane rehearsal was held with the Radio Chemists removing gas-bags and filters at Eniwetok and Roi-Namur respectively. Because of delay in re-entry of the lagoon on Queen Day, no practice small party rehearsal was held. Queen Day operations were declared officially at an end at 1600 L.

An incidental test on Queen Day was the link test to the LSM-60 without anybody aboard, simulating as much as possible Baker Day operation. This test was satisfactory in all respects.

Between Queen Day and Able Day the majority of the time on board the Cumberland Sound was used in preparation for Able Day operation. No further tests were made with the LSM-60, and she was taken to Kwajalein on 27 June. The final checks on the Black Boxes ended on 29 June.

(4) Able Day. Able minus one was announced on 30 June at 0930 L. First of the field parties to leave ship was the Fastax, followed by Black Box. The Gamma Radiation and the Neutron Radiation parties left soon after. The work went smoothly and all

parties returned to the Cumberland Sound by 1700 L. The Radio Chemists had already arrived at Eniwetok and Roi-Namur, and were also standing by on board the drone boat mother ship, the Begor (APD-127). At 0545 L on Able Day, the Cumberland Sound left the lagoon, arriving on station at 0745 L.

The first practice bomb run was completed at 0830 L; the live run started at 0850 L, and the Test-A bomb exploded at exactly 34 seconds after 0900 L, 1 July 1946, or approximately 5:01 p.m., 30 June 1946, Eastern Standard Time (App. B2, p. 104).

The bomb had left Kwajalein at 0555, aboard the B-29 "Dave's Dream", Aircraft No. 44-27354, piloted by Major W.P. Swancutt. Among the fourteen persons aboard were Ensign David L. Anderson, of the Firing Group of the Los Alamos B-Division (B-1), and Mr. Leon D. Smith, of the Fusing Group of the Los Alamos B-Division (B-2), both serving as weaponeers.

Unfortunately, because of personnel error, the timing signals from minus 20 seconds on were transmitted approximately 15 seconds late and this caused late starting of a number of recording instruments which were arranged to be started by the master timing signal (App. B2, p. 115). This occurrence and the missing of the intended bull's eye by as much as about 2,000 feet (see paragraph 6 above) were the most serious faults in the operation of Test Able--they were in fact the only faults of any material consequence.

The drone boats were successfully operated, and samples were picked up by the Radio Chemists and transferred to Kwajalein via destroyer. At Roi-Namur the Radio Chemists picked up the air

filters from the Navy F6F drones. Both parties, with their samples, were ferried to their Kwajalein laboratories by plane.

The Cumberland Sound re-entered the lagoon Able Day afternoon. The Fastax parties proceeded to their stations to pick up their film, but because of the timing error no suitable records were obtained. On Able plus one and two, the Neutron Radiation party went to the target area and managed to pick up 34 out of 44 samples on board the target ships, and then returned to Los Alamos in order to count the activity. The Gamma Radiation party went out on Able plus two and recovered records from five out of eight installations.

(5) William Day. After Able Day, considerable effort was put into making sure that the links to the LSM-60 would be in perfect order for Baker Day. Work was continued also, however, on the Black Boxes and the Gamma Radiation installations, although there was some delay because an approved target layout was not available until after William Day.

Link tests between the Cumberland Sound at sea and the LSM-60 in the lagoon were conducted on 7, 11, 13, 14 and 15 July, with success reported on all tests except that on 15 July.

William minus one day was declared on 18 July, and regular "minus one" day operations were carried out. In addition, parties went to the LSM at 2030 L and were joined by Section Leader Herbert Hall and William Roby (of the Firing Section of B-12) at 0430 L on William Day. Dr. Holloway was evacuated to the Cumberland Sound at 0545 L, with the other personnel remaining aboard to

watch operations.

On William Day, 19 July 1946, the Cumberland Sound left her berth and stood off Enyu Island until Dr. Holloway came aboard. At 0730 L the ship was on station, 15 nautical miles from point Zero. Because of weather conditions, "How" hour was postponed 30 minutes and the rehearsal bomb was detonated at 0905 L. The operation was successful, although one repeat-back link failed because of generator failure on board the LSM-60. A flash bomb simulating the bomb, but fired by Black Box signals, went off early because of spurious signals.

Re-entry practice operations were continued that day and William Day activities ended at 1600 L.

(6) Baker Day. The interim between William Day and Baker Day was used for putting equipment in final working shape. On 23 July the Cumberland Sound went to sea again to give standard signals to the Black Boxes. At the same time a successful test was held with the LSM-60.

Baker minus one day was declared at 0900 L, 24 July. The same morning the Fastax and the Gamma Radiation parties left the ship for their stations. Parties left for the LSM-60 to make final tests. At 1200 L Dr. Holloway locked all timing transmitters on the Cumberland Sound and gave the keys to Mr. Warner on the LSM. That night, after all parties had returned, Dr. Holloway and Dr. Hall went to the LSM-60 to spend the night.

At 0500 L on Baker Day, the Cumberland Sound left her anchorage and at 0620 L the last evacuation party from the LSM-60 came

aboard. The Cumberland Sound arrived at station at 0715 L. All operations were carried out successfully, and the Test-B bomb was detonated at 59.7 seconds after 0834 L, 25 July 1946, or approximately 4:35 p.m., 24 July 1946, Eastern Standard Time (App. B2, p. 151). After bomb detonation, the Radio Chemists, again using drone boats, acquired radioactive samples from the center of the target array. These samples were taken to Kwajalein by ship. Air samples were acquired and transmitted to Kwajalein by procedures identical with those used for Test Able.

At 1500 L the same day, the Cumberland Sound re-entered the lagoon, taking a position in the lee of Enyu Island. The same afternoon the film from Enyu Island was evacuated. On Baker plus one, all equipment was evacuated from Enyu. On Baker plus three, film was taken from Bikini and that afternoon the Cumberland Sound put out to sea because of possible radiological danger in the lagoon. The ship came back the afternoon of Baker plus four, and all equipment was evacuated from Bikini. The next morning, Baker plus five, the ship arrived at her old berth in the lagoon, and the Gamma Radiation party went out and recovered their records as well as their equipment. The Black Boxes were also recovered the same day.

On 1 August, the Cumberland Sound left the lagoon, and arrived at San Pedro, California, on 12 August 1946.

9. Manhattan District Personnel.

In the foregoing paragraphs of this chapter mention has been made of the names of many personnel of the Manhattan District who

took a direct part in Operation Crossroads, and in most cases an indication has been given of the contributions made by each one. It has not been feasible in all cases, however, to distinguish clearly between those who belonged to the Manhattan District and those who did not; indeed, it is in some cases difficult to determine such a distinction accurately. In preparing the recapitulation which follows, of the principal Crossroads Operation personnel of the Manhattan District and their contributions, the intention has been to include the names of all those of importance who were, or had been previously, directly connected with the Manhattan District. It may well be that errors of omission have been made; if so, the author of this chapter regrets them and assumes full responsibility for them.

Because the bombs used in the tests were manufactured by the Manhattan District, it is correct to say that nearly every person in the District had an indirect part in the operation. This recapitulation is confined, however, to direct participants only.

Major General L.R. Groves. As Commanding General of the Manhattan Project, General Groves directed or approved the parts played in the operation by the Manhattan District as a whole and by its component organizations and individuals. He served also as consultant to the Task Force Commander. He and members of his Washington headquarters staff, together with certain civilian consultants, served as an advisory group to Admiral Blandy from the initial conferences through all stages of planning, for such items as the target layout, fuel and ammunition loading of ships,

security measures, location of detonation points for both bombs, and censorship of photographs. This group also advised the Army Chief of Staff on Crossroads matters which were referred to the Joint Chiefs of Staff. General Groves also served with the Military Advisory Board to the Officer-in-Charge of the Atomic Bomb Project, and this Board attended important conferences at which plans for the operation were formulated. (App B1, paragraph 84; B3, 3.21.)

Rear Admiral W.S. Parsons. The appointment of Admiral Parsons as Deputy Task Force Commander for Technical Direction has been described in paragraph 5 above. In this key position and as Commander of Task Group 1.1, the Technical Group, he directed all the technical and scientific activities of the Operation, and he served as liaison officer between the Task Force and the Manhattan District. Admiral Parsons also served as a member of the LeMay Subcommittee of the Joint Staff Planners, and, as alternate for Admiral Purnell, on the Military Advisory Board to the Officer-in-Charge of the Atomic Bomb Project. (App. B3, 3.24, 3.25.)

Major General T.F. Farrell. General Farrell had served as executive officer of the Manhattan Project and as deputy to General Groves. He had served as field commander of the Hiroshima and Nagasaki missions and of the Manhattan District survey groups who had entered Japan shortly after the cessation of hostilities to evaluate the effects of the two combat bombs. General Farrell had retired to private life (in the New York State Department of Public Works), when he was appointed a member of the Evaluation

Board created by the Joint Chiefs of Staff. The membership of this Board was announced 28 March 1946; in addition to General Farrell, it included: Dr. K.T. Compton, President of Massachusetts Institute of Technology, Chairman; Mr. Bradley Dewey, President of the American Chemical Society, Vice Chairman; General J.W. Stilwell, Commanding General, Sixth Army Area (succeeded, after his death, by Lt. General A.C. Wedemeyer, Commanding General, Second Army); Lt. General L.H. Brereton, on Special Duty in the Office of the Secretary of War; Vice Admiral J.H. Hoover, a member of the Navy General Board; Rear Admiral R.A. Ofstie, Senior Navy Member of the U.S. Strategic Bombing Survey. (App. 32, page 182.) Lt. Colonel S.A. Derry, of the Washington headquarters of the Manhattan District, served as secretary of this Board (App. 31, Paragraph 24).

The functions of the Evaluation Board were: to be available for advising the Commander of Joint Task Force One in his planning of the tests; and to prepare and present to the Joint Chiefs of Staff an evaluation of the results of the tests.

(The Evaluation Board must not be confused with the Evaluation Commission, which was appointed by the President for similar purposes and included some of the same men in its membership, which was as follows: Senator C.A. Hatch; Senator Leverett Saltonstall; Representative W.G. Andrews; Representative Chet Holifield; Dr. K.T. Compton; Dr. E.U. Condon, Director of the National Bureau of Standards; Mr. Bradley Dewey; Mr. W.S. Newell, President of the Bath Iron Works Corporation; Mr. Fred Searls, Jr., special assistant

to the Secretary of State.) (App B2, page 183.)

Colonel Stafford L. Warren. As Chief of the Medical Section of the Manhattan District, Colonel Warren was the logical man to serve as head of the Radioactivity Group of Operation Crossroads, and to serve as Radiological Safety Advisor to the Commander of Joint Task Force One. The functions, organization and activities of the Radioactivity Group have been described in Paragraph 7 above. Colonel Warren's responsibility for the protection of personnel from the radiological hazards, particularly after Test Baker, was a heavy one. It is greatly to his credit that not a single one of the 42,000 personnel involved was seriously injured by radioactivity—despite the desire of those concerned with important phases of the tests to return to dangerous areas as soon as possible (App. B2, page 48).

Dr. N.E. Bradbury. As Director of the Los Alamos Laboratory, Dr. Bradbury directed the cooperative action of that Laboratory in its important contributions to Operation Crossroads, established the Special B-Division of the Laboratory, and, in addition, served as a special consultant both in Washington and at Bikini; all of these activities are described in greater detail elsewhere herein. (See Vol. 2; also App.A4; A5, 5.44.)

Dr. R.A. Sawyer. The brevity of the connection of Dr. Sawyer with the Manhattan District prior to his appointment as Technical Director of Operation Crossroads has been described in paragraph 7 above. Nevertheless, especially because he held the title of Associate Director of the Los Alamos Laboratory, his name belongs

in this recapitulation. His contributions to the operation were important. As described in the Technical Report of 18 November 1946, his responsibilities, under Admiral Parsons, "included planning, administration, coordination, and supervision of measurement of pressure, radiation, waves, radioactivity, and other 'direct effects' of the explosion (but not determination of damage to ships and material and not determination of injury to animals)". (App. B3, S.54)

Dr. M.G. Holloway. Dr. Holloway had been one of the initial scientific personnel at Los Alamos Laboratory and even before this Laboratory was started he had served on Manhattan District work, as the head of a group at Purdue University, under the general direction of Dr. J.R. Oppenheimer. At Los Alamos he served as a Project Engineer in the G (Weapon Physics) Division, and he shared with Dr. Philip Morrison the responsibility of designing the pit assembly of the bomb. For Operation Crossroads he served as head of the B-Division, and he also headed the Measurements Group of that Division, with headquarters on the Cumberland Sound. (See Vol. 2; also, App. B4, B5.)

Mr. R.S. Warner. Mr. Warner had long been active at Los Alamos. He had served on the Weapons Committee--the technical policy committee--for the project of establishing an overseas operating base at Tinian, for the combat use of the atomic bomb (Project Alberta), and he had headed the Fat Man Assembly Team on that project. For Operation Crossroads, Mr. Warner served as Associate Division Leader of B-Division and as alternate to Dr. Holloway, and he headed the Assembly Section of that Division. (See Vol. 2; also, App. B4.)

Other personnel of the B-Division are shown on the organization charts in Appendix A. These charts are identified as follows:

(1) Assembly Section of B-Division, as of 8 March 1946.

(2) Measurement Section of B-Division, as of 25 March 1946.

(3) B-Division Measurement Section, as constituted during the operation overseas.

Eliminating the duplications in the names included on these charts, 141 persons are named. All of these served as personnel of the Manhattan District. Arranged in alphabetical order, they are as follows:

Adams, R.M.
Aeby, Jack
Alpine, Paul
Anderson, Ens. David L.
Arthur, Bryan E.
Austen, H.N.
Bales, Edgell
Barnes, Philip M.
Barrett, A.
Barrick, J.
Bartlett, Allen
Barton, David
Bayer, Lawrence
Bice, R.A.
Blackford, William
Bond, Avery
Bowman, M.G.
Bragdon, Edwin
Brinn, R.
Brixner, Berlyn
Brown, Leon
Burditt, William
Burriss, Lt. Comdr. S.
Cabot, Tom
Calosa, Vincent
Clancy, Michael
Collins, Arthur
Conrad, Ralph L.
Corl, Saretta, T/5
Cowan, George
Dailey, Philip H.
Davis, Neil
Davis, T.V.
De Selm, C.H.
De Witt, E.G.
Diaz, Manuel
Diener, L.L.
Dodds, Edwin L.
Dumanian, John
Durand, Erie
Engelkemeir, Don
Eyester, Dr.
Fortine, Frank
Fowler, Glen A.
Gabrielson, Harvey
Geiger, F.E.
Goldstein, Albert
Greening, H.G.
Hall, Herbert
Hamilton, Ira
Hammel, H.M.
Harms, Donald C.
Harris, Virgil
Hartshorn, Capt. W.F.
Hemker, William
Henderson, R.W.
Hermann, E.C.
Hildebrand, Lt.Comdr. R. H.
Hill, Orville
Hillis, Lenella,T/5
Hirshfelder, J.
Holloway, Marshall G.
Holm, Robert
Hoogterp, Carlton
Horan, Anna M.
Hull, Mac, Jr.
Jamieson, W.A.
Jerrems, A.S.
Johnson, Rodney W.
Khym, J.
Klein, Joseph
Knapp, R.A.
Knudsen, Arthur
Koester, George A.
Konopinski, Marian
Kreisenbeck, Paul,T/5
Lanahan, Thomas B.
Larkin, William
Lawrence, William
Lehr, H.M.
Linenberger, C.A.
Livingston, Donald C.
Logan, T.R.
Maehen, Arthur
Magee, John
Mainhardt, Robert M.
Mastick, Donald
May, Jack
McCord, W.O., Jr.
Metcalf, Richard
Miles, John
Miller, Donald
Montgomery, Theodore

Maley, Norman	Rubinson, William	Tilley, George P.
Medzel, V.A.	Rudenberg, Gunther	Titterton, E.W.
Meresco, Morris	Russ, Harlow W.	Tusk, James
Newell, Arthur	Russell, John M.	Van Vessem, Alvin D.
Ogle, William	Schreiber, R.E.	Warner, Roger S., Jr.
Ortis, Roberta	Schultz, Raymond	Warren, Martin
Parker, Francis, T/4	Schumaker, H.G.	Webster, R.O.
Perlman, T.	Slotin, L.S.	Weiss, Herbert
Podlesak, Irene	Smith, Leon D.	Wiebeldt, James
Prince, Sidney L.	Stanley, Charles	Wiesner, Jerome
Raub, L. G.	Stewart, William R.	White, Roger
Rieds, John R.	Stiles, John F.	Whitworth, Lennie
Roark, Maj. R.L.	Stradford, Leroy M.	Wilhoyt, Lt.Col. Ellis E.
Roby, William	Tayler, Raymond	Young, Dorris
Roebuck, Kenneth G.	Thompson, L.B.	Young, Harold E.
Rohlfing, Walther J.	Thornton, Gunnar	Young, Miriam, T/5

10. Results and Conclusions.

The most important results of Operation Crossroads may be described as follows (App. B1, paragraph 92):

a. It was demonstrated that a properly placed atomic bomb, either in the air or underwater, will sink a capital ship at close range, damage heavy ships within 500 yards, and damage light ships within 1,000 yards.

b. It was demonstrated that the radioactivity generated by the explosion of an atomic bomb is a major casualty producing effect.

c. Many data were collected on the effects of the atomic bomb concerning blast pressure, heat, radioactivity of fission products, radiation of neutrons, gamma rays, alpha and beta particles, biological reactions, and electronics.

d. The Navy and the Army, by study of the effects on their equipment which was exposed at Bikini, will be enabled to design equipment in the future with knowledge as to how to protect against the atomic bomb.

[redacted]

An informative and thought-provoking comparative evaluation of the two tests of Operation Crossroads may be found in the last section of the "Preliminary Statement of the Evaluation Board", released by the White House on 2 August 1946. This section is headed "Observations and Conclusions, Both Tests" and reads as follows (App. B2, pages 198, 199):

"The operations of Joint Task Force One in conducting the tests have set a pattern for close, effective cooperation of the Armed Services and civilian scientists in the planning and execution of this highly technical operation. Moreover, the tests have provided valuable training of personnel in joint operations requiring great precision and coordination of effort.

"It is impossible to evaluate an atomic burst in terms of conventional explosives. As to detonation and blast effects, where the largest bomb of the past was effective within a radius of a few hundred feet, the atomic bomb's effectiveness can be measured in thousands of feet. However, the radiological effects have no parallel in conventional weapons. It is necessary that a conventional bomb score a direct hit or a near miss of not more than a few feet to cause significant damage to a battleship. At Bikini the second bomb, bursting under water, sank a battleship immediately at a distance of well over 500 feet. It damaged an aircraft carrier so that it sank in a few hours, while another battleship sank after five days. The first bomb, bursting in air, did great harm to superstructures of major ships within a half-mile radius, but did only minor damage to their hulls. No ship within a mile

[redacted]

of either burst could have escaped without some damage to itself and serious injury to a large number of its crew.

"Although lethal results might have been more or less equivalent, the radiological phenomena accompanying the two bursts were markedly different. In the case of the air-burst bomb, it seems certain that unprotected personnel within one mile would have suffered high casualties by intense neutron and gamma radiation as well as by blast and heat. Those surviving immediate effects would not have been menaced by radioactivity persisting after the burst.

"In the case of the underwater explosion, the air-burst wave was far less intense and there was no heat wave of significance. Moreover, because of the absorption of neutrons and gamma rays by water, the lethal quality of the first flash of radiation was not of high order. But the second bomb threw large masses of highly radioactive water onto the decks and into the hulls of vessels. These contaminated ships became radioactive stoves, and would have burned all living things aboard them with invisible and painless but deadly radiation.

"It is too soon to attempt an analysis of all of the implications of the Bikini tests. But it is not too soon to point to the necessity for immediate and intensive research into several unique problems posed by the atomic bomb. The poisoning of large volumes of water presents such a problem. Study must be given to procedures for protecting not only ships' crews but also the populations of cities against such radiological effects as were demonstrated in

Bikini lagoon.

"Observations during the two tests have established the general types and range of effectiveness of air and shallow underwater atomic-bomb bursts on naval vessels, army materiel, including a wide variety of Quartermaster stores, and personnel. From these observations and from instrumental data it will now be possible to outline such changes, not only in military and naval design but also in strategy and tactics, as future events may indicate.

"National security dictates the adoption of a policy of instant readiness to defend ourselves vigorously against any threat of atomic weapon attack at any time and adherence to this policy until it is certain that there can never be an atomic war. One enduring principle of war has not been altered by the advent of the atomic weapon. Offensive strength will remain the best defense. Therefore, so long as atomic bombs could conceivably be used against this country, the Board urges the continued production of atomic material and research and development in all fields related to atomic warfare."

[redacted]

BOOK VIII, VOLUME 5

CHAPTER 8, OPERATION CROSSROADS

APPENDICES

A: Organization Charts

1. Organization Chart: Assembly Section of B-Division, as of 6 March 1946
2. Organization Chart: Measurement Section of B-Division, as of 25 March 1946
3. Organization Chart: B-Division - Measurement Section, as constituted during the operation overseas

B: References

[redacted]

ASSEMBLY SECTION OF B DIVISION

As of 8 March 1946

Roger S. Warner, Jr.
Lt. Col. Ellis E. Wilhoyt, Jr., Glen A. Fowler, R. W. Henderson
Thomas B. Lanahan, H. G. Greening, Donald Mastick

B-1 Firing
Group Leader
W.O. McCord, Jr.

Ensign David L. Andersen
Frank Fortine
Donald C. Harms
Arthur Collins
Robert M. Mainhardt
Walther J. Rehlfing
E. C. Hermann

Data
George P. Tilley
Vincent Calcea

B-2 Fuzing
Group Leader
Mr. George A. Koester

Wm. Hemker
Leon D. Smith
Philip M. Barnes
L. G. Raub
Joseph Klein
William Larkin
Leroy M. Stradford

B-3 Assembly
Group Leader
Arthur Machen

Bryan E. Arthur
Alvin D. Van Vessem
William R. Stewart
Philip H. Dailey
Ira Hamilton
Kenneth O. Roebuck

HE
Dr. Eyester
John H. Russell

B-4 Engineering
(R.W. Henderson)
R.A. Bice

B-5 Pit
Group Leader
R.B. Schreiber

L.S. Slotin
H.M. Hammel
Neil Davis
L.B. Thompson
T. Perlman

B-6 Logistics-Supply
Group Leader
Marlow W. Russ

John R. Riede
Raymond Schultz
Avery Bond
H.G. Schwaner
Technical Stockroom
Arthur Newell
Theodore Montgomery

B-7 Air Coordination
Group Leader
(Glenn A. Fowler)
Assistant Group Leader
C.H. DeSelm
Wright Field Liaison
Maj. R.L. Roark
Air Coordination
Capt. W.F. Hartshorn
R.A. Knapp
Armament
R. Brinn

Air Collection
T. V. Davis
W. A. Jamieson
Communications
R.B. Austen
Martin Warren
Photography
Supply
T.R. Logan
Design
Virgil Harris
A. Barrett
John Miles
Michael Clancy

App. A-1

SECRET

App. A-2

MEASUREMENT SECTION OF B DIVISION

Marshall G. Holloway
Lawrence Bayer, H. M. Lehr, V. A. Nedzel
Marian Knapinski, Secy., Dorris Young, Typist

As of 25 March 1946

B-9 Pastax
Group Leader
Berlyn Brixner

Jack Aeby
Allen Bartlett
Ralph L. Conrad
F. E. Geiger
Carlton Hoogterp

B-10 Fast Neutron
Group Leader
G. A. Linenberger

Leon Brown
William Ogle

B-11 Gamma Timing
Group Leader
Norris Noreson

William Burditt
Arthur Knudsen
Donald Miller

B-12 Timing
Group Leaders
Jerome Wiesner
Herbert Weiss

L. L. Diener
R. O. Webster

Timing:
Eric Durand, Sec.Ldr.
Ed Bales
William Blackford
John Dumanian
John F. Stiles

Firing:
Herbert Hall, Sec.Ldr.
Paul Alpine
Edwin L. Dodds
Norman Haley
William Roby

Gamma Timing:
A. S. Jerrems, Sec.Ldr.
Tom Cabot
Manual Diaz
Robert Holm
Rodney W. Johnson
Donald C. Livingston

B-13 Condenser Gauge
Group Leader
James Wiebeldt

David Barton
Edwin Bragdon
Paul Kreisenbeck, T/5
William Lawrence
Francis Parker, T/4
Guether Rudenberg
Raymond Taylor
Gunnar Thornton
Harold E. Young

B-14 Radiochemistry
Group Leader
William Rubinson

R. M. Adams
J. Barrick
M. G. Bowman
Seretta Corl, T/5
George Cowan
E. G. DeWitt
Don Engelkemeir
Albert Goldstein
Orville Hill
Lousila Hillis, T/5
J. Knyn
Jack May
Richard Metcalf
Roberta Ortis
Charles Stanley
Miriam Young, T/5
Irene Podlesak, Secy.

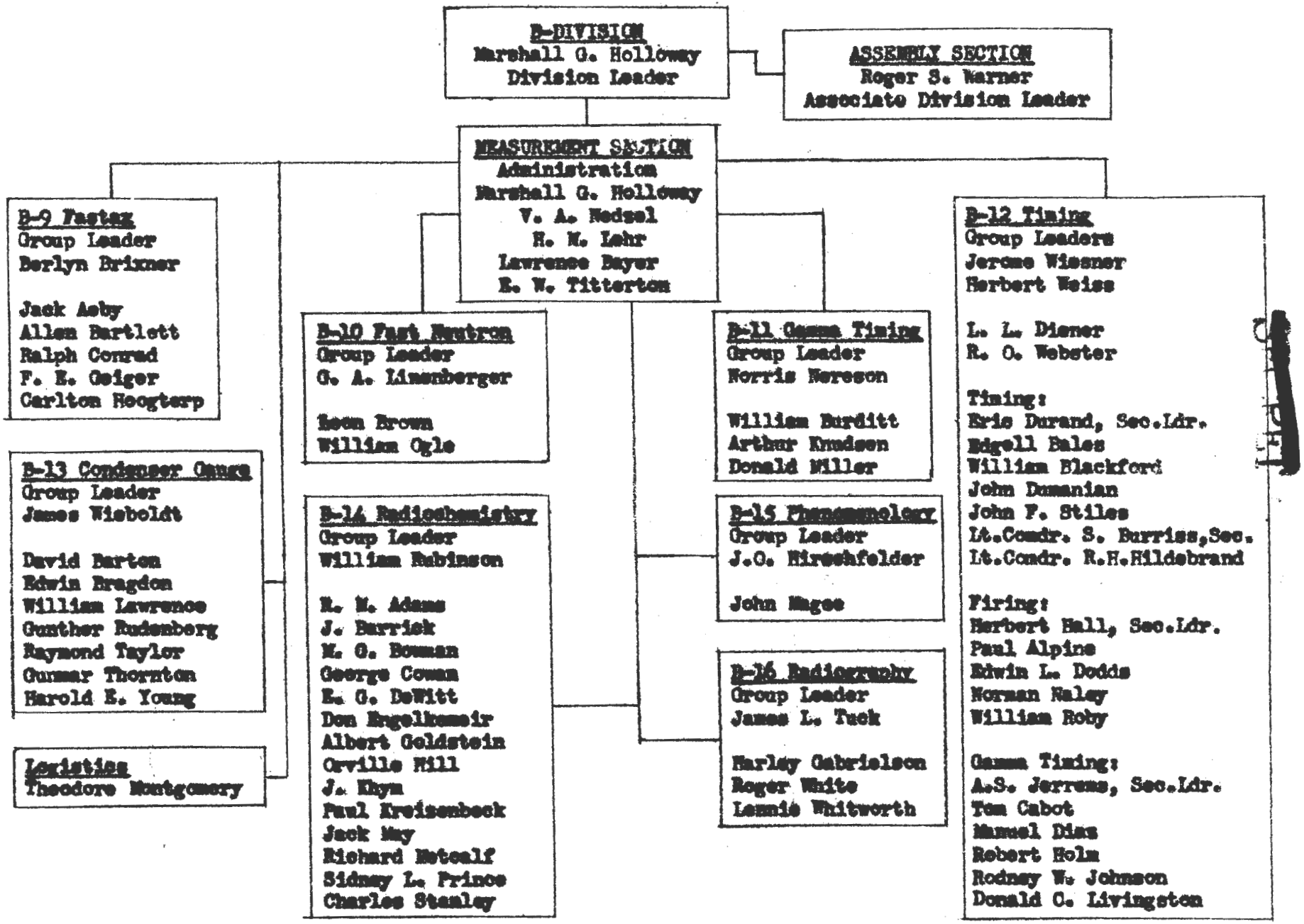
B-15 Phenomenology
Group Leader
J. Hirschfelder

Mac Hull, Jr.
John Magee
Anna M. Horan, Secy.

B-16 Radiography
Group Leader
James Tuck

Harvey Gabrielson
Roger White
Lennie Whitworth

SECRET


B-DIVISION
Marshall G. Holloway
Division Leader
ASSEMBLY SECTION
Roger S. Warner
Associate Division Leader
MEASUREMENT SECTION
Administration
Marshall G. Holloway
V. A. Nedzel
H. M. Lehr
Lawrence Bayer
R. W. Titterton
B-9 Fastax
Group Leader
Berlyn Brixner
Jack Asby
Allen Bartlett
Ralph Conrad
F. E. Geiger
Carlton Hoogterp
B-10 Fast Neutron
Group Leader
G. A. Linenberger
Leon Brown
William Ogle
B-11 Gamma Timing
Group Leader
Norris Noreson
William Burditt
Arthur Knudsen
Donald Miller
B-12 Timing
Group Leaders
Jerome Wiesner
Herbert Weiss
L. L. Diener
R. O. Webster
Timing:
Eric Durand, Sec.Ldr.
Edgell Bales
William Blackford
John Domanian
John F. Stiles
Lt.Comdr. S. Burriss,Sec.
Lt.Comdr. R.H.Hildebrand
Firing:
Herbert Hall, Sec.Ldr.
Paul Alpine
Edwin L. Dodds
Norman Raley
William Roby
Gamma Timing:
A.S. Jerrems, Sec.Ldr.
Tom Cabot
Manuel Diaz
Robert Holm
Rodney W. Johnson
Donald C. Livingston
B-13 Condenser Gauge
Group Leader
James Wieboldt
David Barton
Edwin Bragdon
William Lawrence
Gunther Rudenberg
Raymond Taylor
Gunnar Thornton
Harold E. Young
B-14 Radiochemistry
Group Leader
William Robinson
R. M. Adams
J. Barrick
M. G. Bowman
George Cowan
E. G. DeWitt
Don Engelkemeir
Albert Goldstein
Orville Hill
J. Khym
Paul Kreisenbeck
Jack May
Richard Metcalf
Sidney L. Prince
Charles Stanley
B-15 Photomechanics
Group Leader
J.O. Hirschfelder
John Magee
B-16 Radiography
Group Leader
James L. Tuck
Harley Gabrielson
Roger White
Lennie Whitworth
Logistics
Theodore Montgomery

SECRET

[redacted]

APPENDIX B

REFERENCES

(MDH: Manhattan District History Files: AFSWP: Files of Armed Forces Special Weapons Project)

1. Operation Crossroads; an account prepared by Major Philip G. Krueger. (Par. 81-92.) (SECRET) MDH

2. Bombs at Bikini, The Official Report of Operation Crossroads. Prepared under the Direction of the Commander Joint Task Force One, by W. A. Shurcliff, Historian of Joint Task Force One; published 1947, by Wm. H. Wise & Co., Inc., New York. AFSWP

3. Technical Report of Operation Crossroads. Prepared for Commander Joint Task Force One for Transmittal to the Joint Chiefs of Staff and their Evaluation Board; by Dr. W. A. Shurcliff, Historian, assisted by: Mr. D. Z. Beckler, Deputy Historian; Mr. Peregrine White, Assistant Historian; Mrs. Virginia Shapley, Editor, and others. 18 November 1946. (TOP SECRET) AFSWP

4. History of Los Alamos B-Division, 30 April 1946. In two parts: History of Los Alamos B-Division; Los Alamos B-Division Measurement Section - Technical Responsibilities. (RESTRICTED) MDH

5. Overseas History B-Division - Measurement Section - Operation: Crossroads. Submitted by Herbert M. Lehr; approved by M. G. Holloway - 15 August 1946. (SECRET) MDH

[redacted]